# Test and Evaluation/Science and Technology

## Embedded Instrumentation

## FY04 Broad Agency Announcement:

***An Opportunity to Shape Technology into Tomorrow's T&E Capability***

**NET3 Conference & Exhibition**
**Rosen Centre, Orlando FL**
**23 July 2003**

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# Embedded Instrumentation
## Broad Agency Announcement—Overview

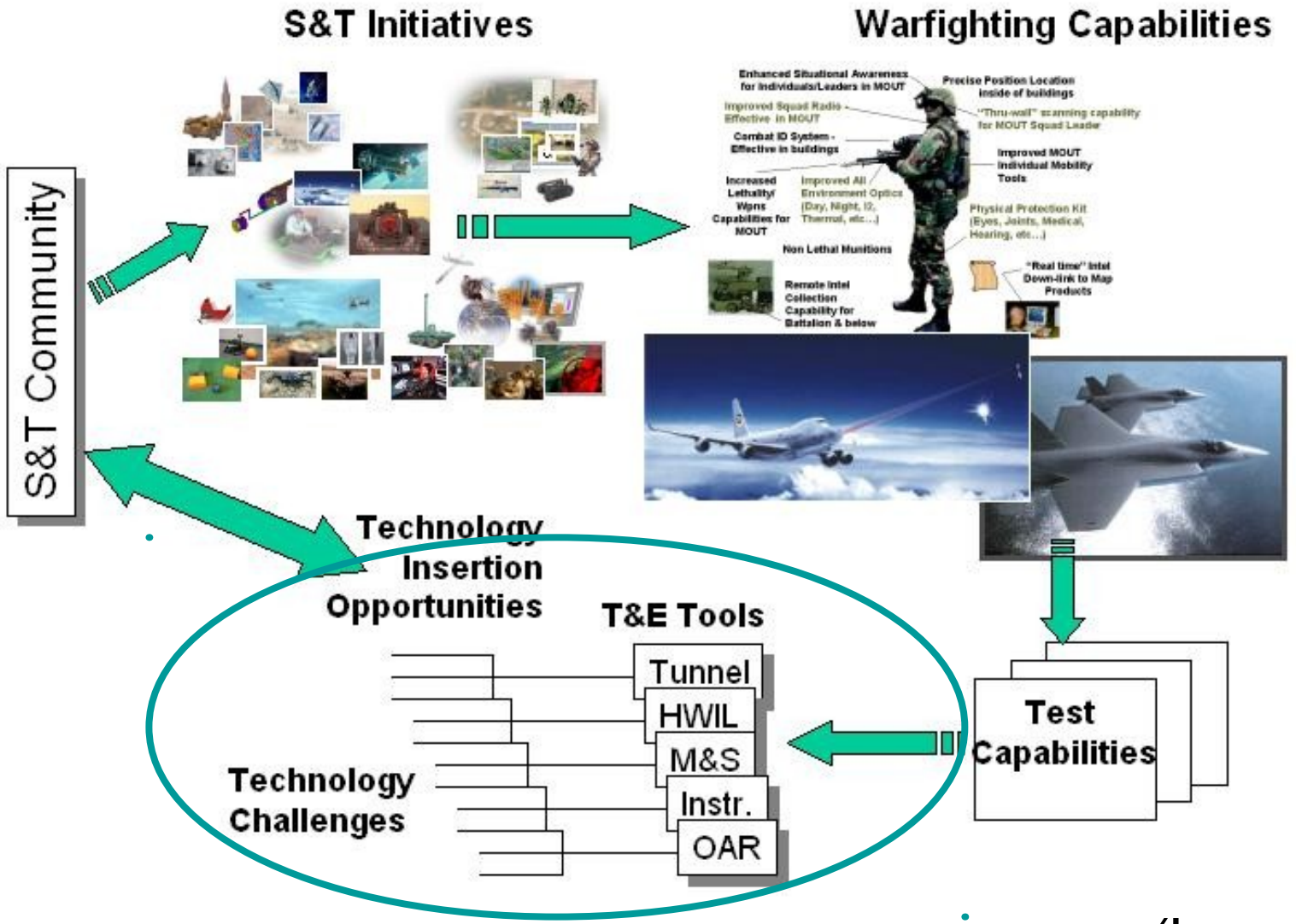
- Test and Evaluation/Science and Technology (T&E/S&T) Program
- Embedded Instrumentation (EI) Focus Area
- FY04 EI Broad Agency Announcement (BAA) Section A Contents and Schedule
- FY04 EI BAA Contract Process
- Other Upcoming T&E/S&T Solicitations

# T&E/S&T Program

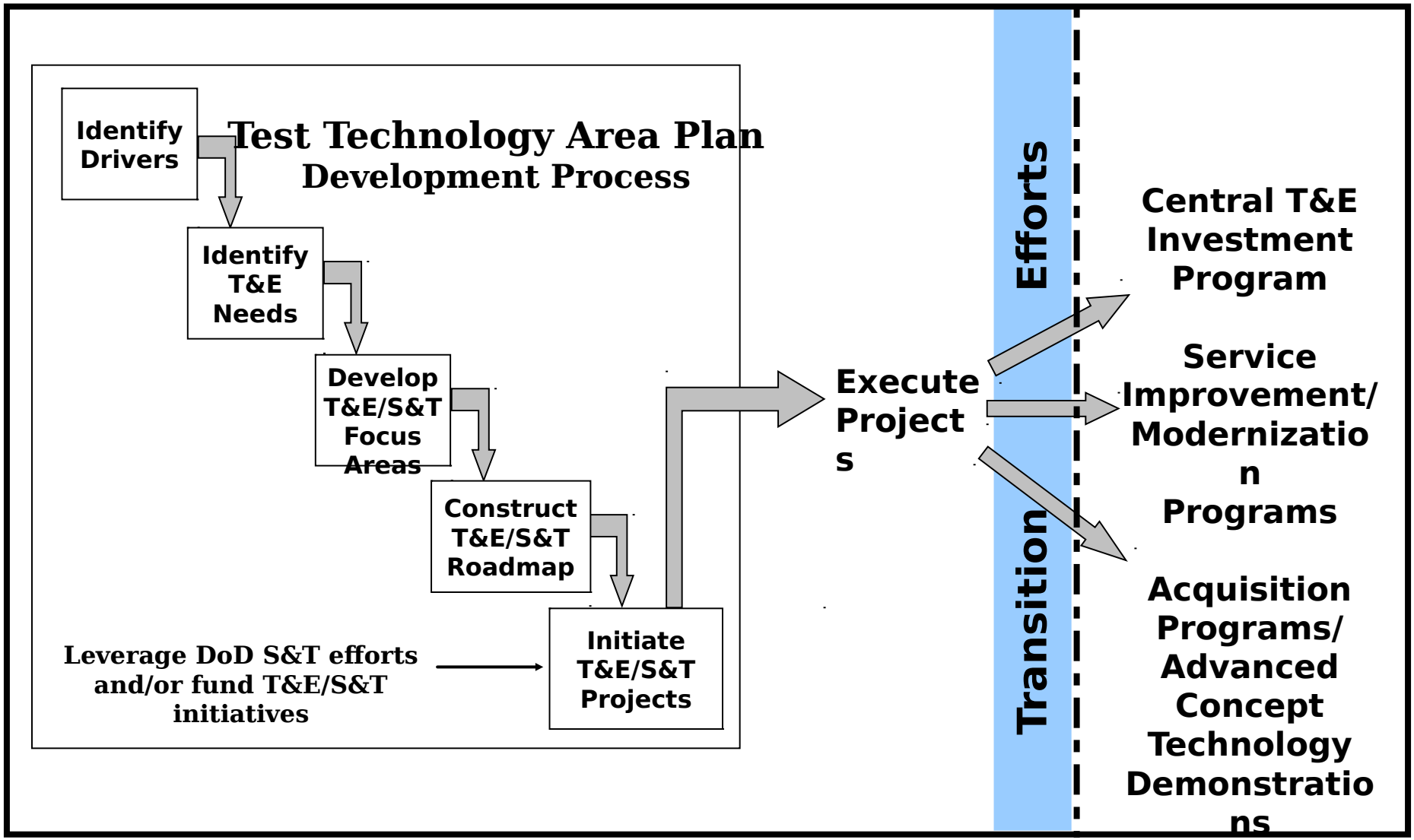
- Program Initiated in FY 2002 under DOT&E
- Challenge: To transform U.S. military capabilities, we must transform T&E capabilities
  - Quadrennial Defense Review (QDR) Transformational Goals
  - Procurement complexity increasing
    - Major systems, systems of systems, upgrades to existing systems, and commercial and non-developmental items
  - Acquisition initiatives
    - Rapid insertion of technology
    - Spiral development, evolutionary acquisition
    - Continuous T&E
  - Operational complexity increasing
    - Network Centric Warfare, Joint Urban Operations, etc.
    - Systems of systems, interoperability, larger footprints
- Program Goal: Exploit new technologies and expedite their transition from the laboratory to T&E capabilities.

**Verify Performance Before Production or Force Deployment Into Harm's Way**

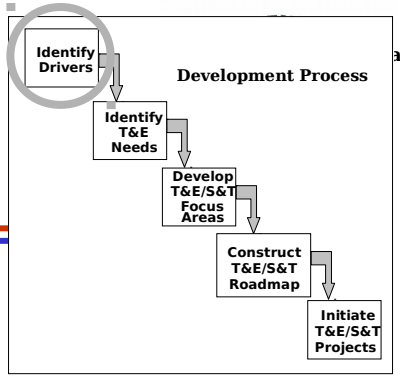
# Technology Identification Process


S&T Initiatives
Warfighting Capabilities
S&T Community
Enhanced Situational Awareness for Individuals/Leaders in MOUT
Precise Position Location inside of buildings
Improved Squad Radio - Effective in MOUT
"Thru-wall" scanning capability for MOUT Squad Leader
Combat ID System - Effective in buildings
Improved MOUT Individual Mobility Tools
Increased Lethality/ Wpns Capabilities for MOUT
Improved All Environment Optics (Day, Night, ID, Thermal, etc...)
Physical Protection Kit (Eyes, Joints, Medical, Hearing, etc...)
Non Lethal Munitions
"Real time" Intel Down-link to Map Products
Remote Intel Collection Capability for Battalion & below
Technology Insertion Opportunities
T&E Tools
Tunnel
HWIL
M&S
Instr.
OAR
Technology Challenges
Test Capabilities

# T&E/S&T Program
## Process Overview

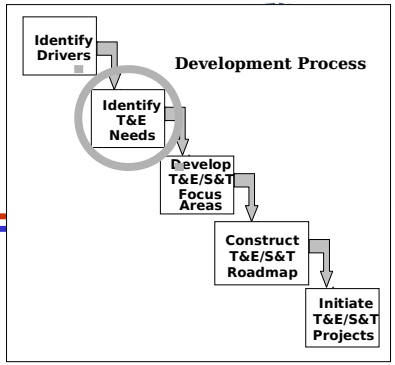


# Test Technology Area Plan
## Identify Drivers



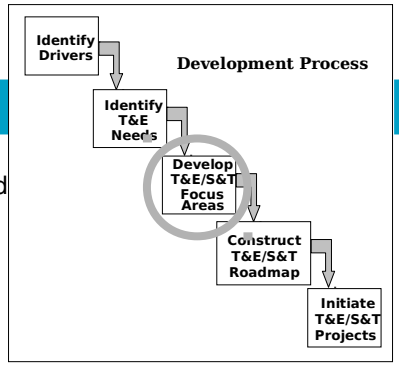

- QDR Transformational Goals
- Director, Defense Research & Engineering (DDR&E) Initiatives
  - National Aerospace Initiative (NAI)
  - Surveillance and Knowledge Systems
  - Energy and Power Technologies
- Defense Planning Guidance T&E Modernization
- Defense Science and Technology Plans
  - Defense Technology Area Plans (DTAPs)
  - Joint Warfighting S&T Plans (JWSTPs)
  - Defense Technology Objectives (DTOs)
- Defense Science Board (DSB) findings
  - DSB Task Force Report on T&E Capabilities (Dec 2000)
  - DSB Task Force Report on DoD Frequency Spectrum Issues (Nov 2000)

# Test Technology Area Plan
## Identify T&E Needs




- Leverage the knowledge of Warfighter, S&T, and T&E subject matter experts
  - Workshops/Conferences
    - DOT&E/DUSD(S&T) Workshop (Mar 2002)
    - DOT&E/DDR&E National Aerospace Initiative (NAI) Hypersonics Workshop (May 2002)
    - DARPA/DOT&E Microelectromechanical Systems (MEMS) Workshop (Jun 2002)
    - International Test and Evaluation Association (ITEA)/Directed Energy Professional Society Conference (Aug 2002)
    - DOT&E Sponsored Strategic Planning Workshop (Sep 2002)
  - Other
    - Review DSB study reports
    - Draft Defense Planning Guidance T&E Task Report
      - Test Resource Master Plan
      - Reliance Assessment Capability Summaries
    - Conduct additional research
- Critical Finding:
  - More technology gaps than anticipated
- T&E/S&T needs grouped into 9 Focus Areas

# Focus Area Start-Up




## FY02

### Hypersonic Test

- Ground/flight test and computational fluid dynamics capabilities for airworthiness, weapons separation, end-game d
- Survivable and continuous instrumentation in a hypersonic environment

### Spectrum Efficient Technology

- Advanced data pre-processing, compression, storage, and transmission for ultra-high data rates
- Capability to operate within and outside of traditional bandwidth-saturated environment

### Multi-Spectral Test

- Multi-spectral and obscurant atmospheric modeling for advanced weapons
- Multi-spectral and hyperspectral target signatures, scene generation techniques

## FY03

### Embedded Instrumentation

- Microelectronics and MEMS for minimizing size, weight, and power drain of onboard components and interfaces
- Advanced algorithms for tightly coupled time-space position and attitude information

### Directed Energy Test

- Survivable on-board and off-board instrumentation
- Ground truth for free-space beam control, path characterization and dispersion, intensity, lethality, and meteorological measurements

## FY04

- Mature and expand FY02 and FY03 focus areas

## FY05

### Information Systems Technology Test

- Information/knowledge management and mining, smart (artificial intelligence) test instrumentation
- Spatial and temporal registration of sensors and communications, capturing and evaluating multiplayer simultaneous activities

### Modeling and Simulation

- Aggregation/disaggregating of models among physics-based, engineering, platform, mission, and theater levels
- Human physiological and psychological performance modeling for test and evaluation

### Test Range/Facility Productivity Improvements

- Range infrastructure that supports testing at any site and in any distributed manner (mobile, self-configuring, network of networks)
- Automated data management tools utilizing advanced visualization techniques (real-time data analysis, insights, and alerts)

## FY06

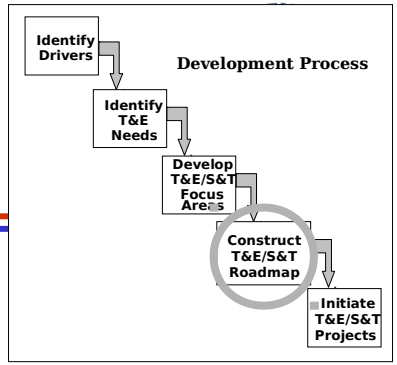
### Software Test

- Detect defects in “learning software” for robotic systems
- Interactions and assurance among distributed software-intensive systems (e.g., network centric)

# T&E/S&T Program
## Focus Area Executing Agents

- **Executing Agent (EA) leads each active focus area**
  - **Hypersonic Test**
    - **Joe Babilon**
    - **Air Force Arnold Engineering Development Center**
  - **Spectrum Efficient Technology**
    - **Saul Ortigoza**
    - **Air Force Flight Test Center**
  - **Multi-Spectral Test**
    - **Frank Carlen**
    - **Army Aberdeen Test Center**
  - **Embedded Instrumentation**
    - **Lisa Davis**
    - **DOT&E/S&TR**
  - **Directed Energy Test**
    - **Mike Dieckhoff**
    - **Air Force Operational Test & Evaluation Center**
- **All current EAs are from the T&E community**

# Test Technology Area Plan
## Construct Roadmaps




- Roadmap for each focus area
- T&E/S&T team mapped the knowledge gained from workshops
- Characteristics of each Roadmap
  - Extends through FY09
  - Goal of focus area is depicted in upper right of chart
  - Active projects in solid blocks
  - Candidate projects in dashed blocks
  - Leveraged S&T efforts identified at the bottom
    - Defense Technology Objectives (DTOs)
    - Defense Advanced Research Projects Agency (DARPA) projects

# T&E/S&T Program Roadmap

| T&E/S&T Focus Area and Goals | FY 2002 | FY 2003 | FY 2004 | FY 2005 | FY 2006 | FY 2007 | FY 2008 | FY 2009 |
|---|---|---|---|---|---|---|---|---|

## FOCUS AREA: EMBEDDED INSTRUMENTATION (EI)

**Embedded instrumentation that supports continuous T&E and leverages training & diagnostic/prognostic instrumentation**

- Miniaturization and reduced-weight sensors and instrumentation packaging
- Reductions in on-board power demands
- Instrumentation command and control
- Advanced algorithms

- Direct Methanol Fuel Cell for Armored Vehicle Instrumentation
- EI Study
- MEMS CO Emissions Sensor
- Compact Holographic Data Storage
- Advanced Munitions Flight Test Instrumentation

- Tactical MEMS Global Positioning System/Inertial Measurement Unit (IMU)
- Telemetry on-a-chip
- Platform instrumentation sensor bus
- MEMS-based tunable transceiver
- Miniaturization and reduced weight sensor instrumentation packaging
- Wireless data and communications transfers and distribution
- Higher bandwidth data encryption
- Plug and play architecture for common usage
- Human performance instrumentation
- On-board power demand reduction
- Command and control instrumentation
- Vehicle power lines as a data bus
- Electro-adhesives
- Advanced algorithms for data fusion

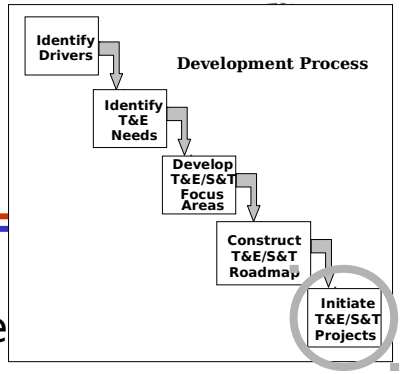
**Leveraged Efforts**

- Affordable, ultra-miniature & ultra low power devices
- Radical reductions in size and power

**DTOs:**

- SE.70 Integrated Compact Electronic Sensors
- SE.89. Micro-Power
- SE.104. Nano-mechanical
- SE 112. Chip-scale atomic
- WE.80 High-g Microelectromechanical Systems Inertial Measurement Unit
- DARPA MEMS programs

# T&E/S&T Program
## FY02 Projects

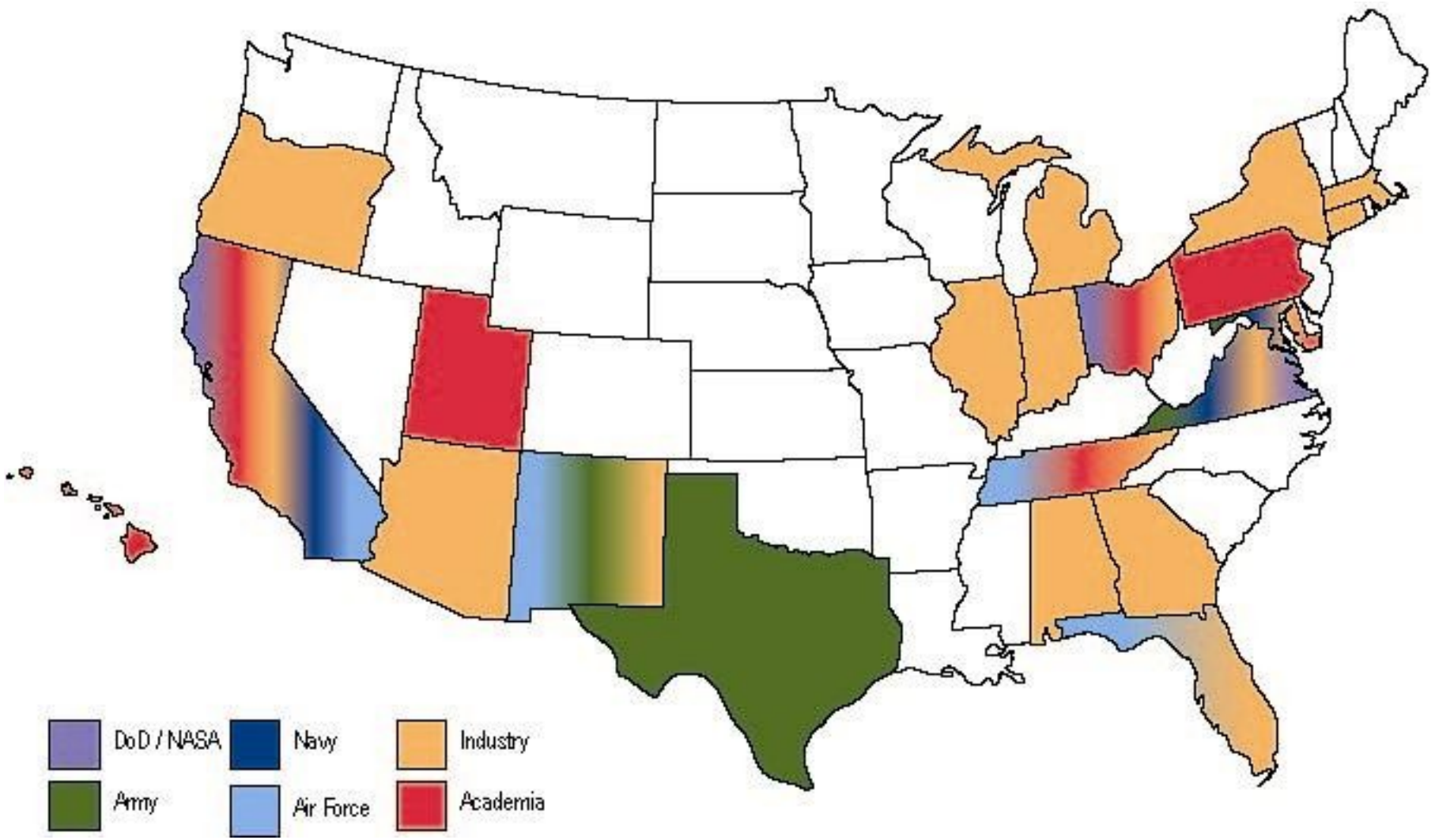



- Hypersonic Test
  - Heat Flux Sensor Development for Aerothermal Measure
  - Advanced Flight Vehicle Instrumentation
  - Hypersonic Wind Tunnel Nozzle Survivability for T&E
  - In-Situ Pressure Measurements for Hypersonic Vehicles
  - Hypersonic Aeropropulsion System Flight Trajectory Test and Evaluation
- Spectrum Efficient Technologies
  - Spectrally efficient, high data rate telemetry system in 3-30 GHz (Super High Frequency)
  - Space time coding for aeronautical telemetry
  - Ground based receiving telemetry antennas
  - Super High Frequency (SHF) channel modeling and implementation
  - M-ary Variable Shift Keying (MVSK)
  - Steerable beam, directional antenna concepts
  - Variable Phase Shift Keying/Feher variant high efficiency modulations
- Multi-Spectral Test
  - Dynamic Hyperspectral Thermal Signature Model
  - Multi-spectral Stimulator Injection Test Method
  - Hyperspectral Performance Scene Generator
  - Hyperspectral Testbed Design

# T&E/S&T Program
## FY03 Projects

- Maturation of promising FY02 projects
- Evaluation/selection of new projects in FY02 focus areas
  - Data Acquisition in Hypersonic Flight
  - Ground Antenna Study
  - Propagation Study
  - Differential Space-Time Coding
  - Advanced Orthogonal Frequency Division Multiplexing Prototype
  - Phased Array Antenna
  - RF MEMS Antenna
  - Hyperspectral Sensor Evaluation—Minimum Resolvable Temperature
- Embedded Instrumentation
  - Direct Methanol Fuel Cell
  - Requirements Definition of Embedded Instrumentation Architecture
  - Carbon Monoxide (CO) Emissions Sensor for Gas Turbine Engines
  - Compact Holographic Data Storage
  - Advanced Munitions Flight Test Instrumentation
- Directed Energy (DE) Test
  - Quantum Well Infrared Photodetectors
  - Data Acquisition Transformation
  - Beam Redistribution System

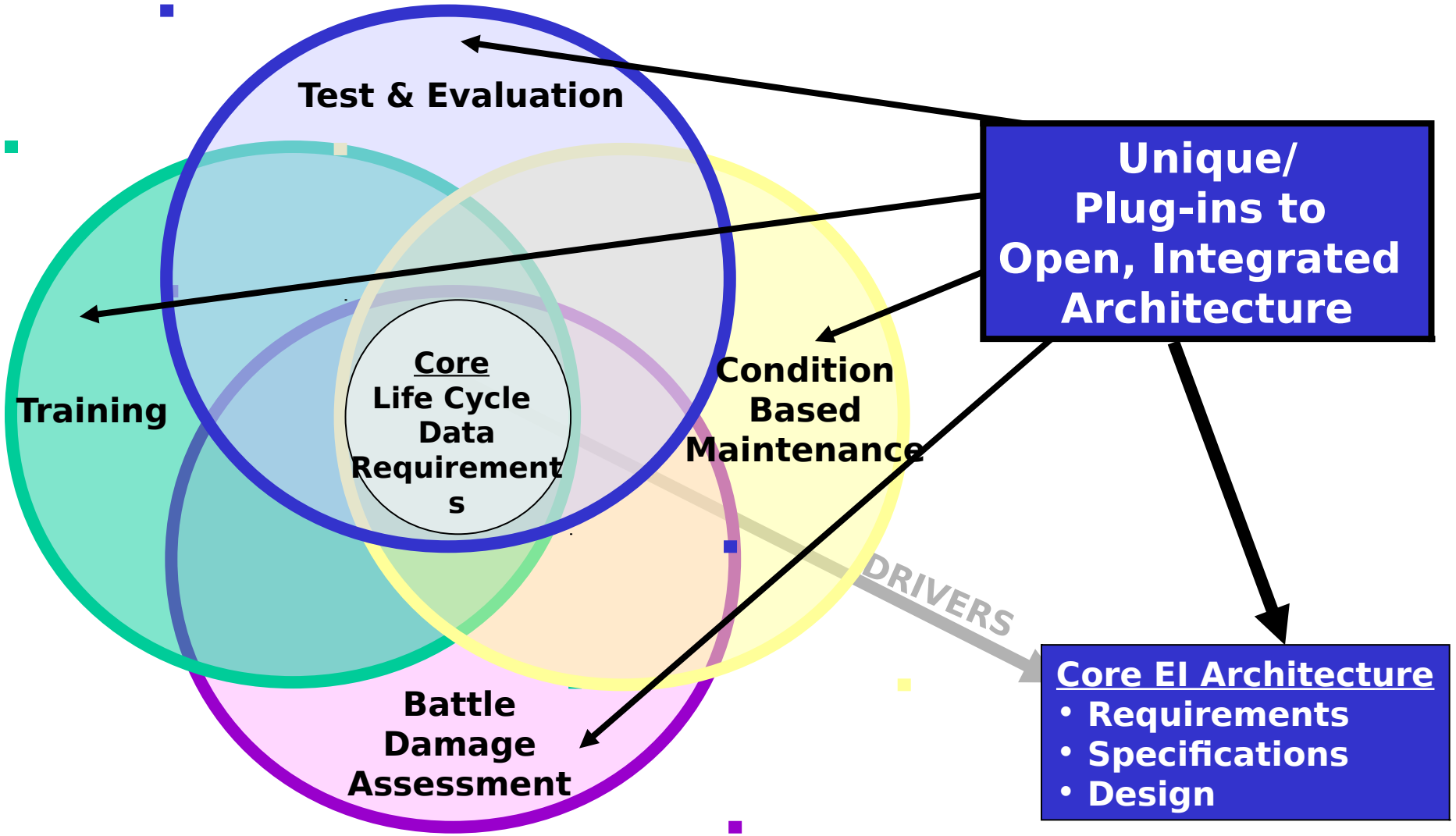
# Distribution of T&E/S&T Efforts



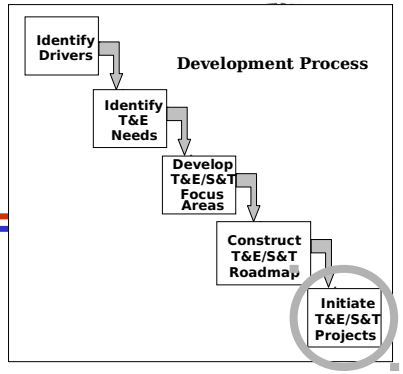
# EI Focus Area
## Goals

- Develop non-intrusive embedded instrumentation architecture and enabling technologies that provide performance data in support of continuous weapon system T&E
- Collaborate with DoD EI Steering Group to support EI as an enabling tool for transformation
  - Diagnostics
  - Prognostics
  - Training
  - T&E

# Embedded Instrumentation
## Overarching Vision



# EI Focus Area
## Process to Initiate FY04 Projects




- Conduct EI study
  - State of the art EI
  - Future EI requirements
  - Identify T&E technology gaps
- Use BAA to address the gaps within constraints of
  - Available budget (~ $2M in FY04)
  - Probable path to transition
- Partnerships are key to success
  - Industry, academia, Services, DARPA, and other agencies

# FY04 EI BAA
## Section A Contents

- 1.0 Definitions/Goals
- 2.0 Scope
- 3.0 Projected Characteristics
- 4.0 Reporting (CDRLs)

# FY04 EI BAA
## 1.0 Definitions/Goals

- General EI Definition: Data collection and processing capabilities integrated into the design of a system for
  - Diagnostics, prognostics, testing, and training

- Specific definitions for this BAA: EI captures a set of data required for T&E throughout the life of the system
  - Desirable to leverage or benefit logistics, training, and battle damage assessment EI efforts
  - Measurement system hardware and/or software that can be fully integrated in military systems
    - Collect, process, transmit, and/or store measurement data
    - Should be transparent to the system user(s) and non-intrusive on system performance and operation

# FY04 EI BAA
## 1.0 Definitions/Goals

- Goal:  Develop components, subsystems and systems for use as embedded T&E instrumentation
  - Demonstrations, prototypes, proofs-of-concept, evaluations
  - No intent to perform basic research

- FY04 EI BAA is focused on new technologies and integration of demonstrated technologies to support T&E of future military systems

# FY04 EI BAA
## 2.0 Scope

- Includes technology developments, demonstrations, and evaluations in following 9 areas of interest (not prioritized)
  - Architecture
  - Sensors
  - Miniaturization of instrumentation
  - Communication networks
  - Data collection, reduction and storage
  - Reliability, durability, maintainability and in-situ calibration
  - Survivability of EI in harsh environments
  - Manufacturing approaches
  - Potential of T&E EI to support training, prognostics, and diagnostics

# FY04 EI BAA
## 3.0 Projected Characteristics

- BAA contains general EI characteristics for 5 groups of systems
  - Air and Space Systems
  - Armaments and Munitions
  - Land Combat Systems
  - Sea Systems
  - Dismounted Soldiers
- 9 areas of interest apply to each system group

# FY04 EI BAA
## 3.0 Projected Characteristics (continued)

- Architecture
  - Integral to standard bus/interface architectures found on host systems
  - Allow for easy access to data and processing on host
- Sensors
  - Operate in wide range of environments*
  - Adequately measure operating characteristics
- Miniaturization
  - Ease of installation
  - Minimal power and weight penalties
  - No adverse effects on system-under-test

*Note: Expected temperatures, shock levels, acceleration, etc. listed in BAA

# FY04 EI BAA
## 3.0 Projected Characteristics (continued)

- Communication Networks
  - Compatible with existing telemetry standards
  - Network capable
- Data collection, reduction and storage
  - Compatible with non-proprietary standards to ensure interoperability among DoD test facilities
- Reliability, durability, maintainability and in-situ calibration
  - Do not want EI to drive host maintenance cycle
  - Lifetime calibration stability or in-situ calibration

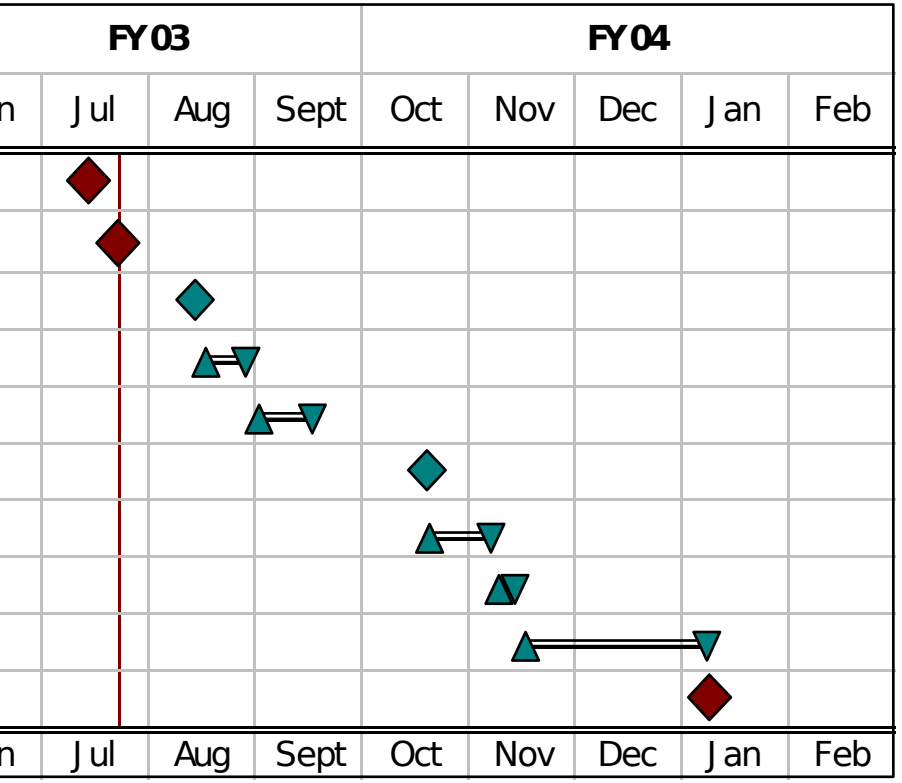
# FY04 EI BAA

## 3.0 Projected Characteristics (continued)

- Survivability in Harsh Environments
  - Same or better than host in natural and man-made environments (interference, countermeasures)
  - During catastrophic system failures, data should be recoverable
- Manufacturing Approaches
  - Prefer integrated EI as part of host manufacturing process
- Potential to support training and maintenance functions
  - T&E EI to leverage as well as support related host EI functions
    - Examples: system health data, built-in-test, structural fatigue, failure rates, device cycles, and system configuration

# FY04 EI BAA
## Schedule

| Activity Name | Start Date | Finish Date |
|---|---|---|
| BAA Published FBO | 7/15/03 | |
| Industry Brief--Orlando | 7/23/03 | |
| **Abstracts Due** | **8/15/03** | |
| Evaluation | 8/18/03 | 8/29/03 |
| Proposal Ltrs | 9/2/03 | 9/17/03 |
| **Proposals Due** | **10/20/03** | |
| Evaluation | 10/21/03 | 11/7/03 |
| OSD Approval | 11/10/03 | 11/14/03 |
| Contract Negotiations | 11/17/03 | 1/8/04 |
| **Contract Awards** | **1/9/04** | |



# Test and Evaluation/Science and Technology

## FY04 Solicitation Announcements:
## Embedded Instrumentation
## Spectrum Efficiency
## Directed Energy

**NET3 Conference & Exhibition**
**Rosen Centre, Orlando FL**
**23 July 2003**

**Senah Williams**
**Contracting Officer**
**AFFTC**
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# Embedded Instrumentation FY04 BAA Contract Process

- Total BAA Contract(s) Dollar Value ~$2M
- Multiple Awards Anticipated
- Type of Contract – Firm Fixed Price
- 2 step process
  - All interested Offerors submit 10 page abstracts
  - Selected Offerors requested to submit full proposals (50 pages)
- Second step proposals requested September 2003
  - Second step Offerors given 30 days to respond with proposal
- Basis for Award- 3 Categories
  - I Well conceived, scientifically and technically sound
  - II Sound but requires further development
  - III Not technically sound or does not meet Agency needs
- Contract Awards early January 2004

# Embedded Instrumentation FY04 BAA Contract Process

- 2004 Contract Announcement
  - –BAA 0004-C-1PKD
- Published in Fedbizopps
  - –Synopsis published on 26 June 03
  - –BAA published on 15 July 03
- Contracting Officer
  - –Ms. Senah Williams
    senah.williams@edwards.af.mil
- All questions and comments outside of this public briefing must be directed through contracting officer

**Notice:** This briefing is for information only. BAA solicitation 0004-C-1PKD is the official contract vehicle for this activity. Nothing in this briefing shall be construed to take precedence over the official solicitation.

# Spectrum Efficient Technology
# FY04 PRDA Contract Process

- Spectrum Efficiencies Program Research and Development Announcement (PRDA) will also be released
  - 6 Topic Areas
    - Spectrum Efficiencies for Joint Urban Operations
    - Automated Spectrum Management
    - Optical Communications
    - Hypersonic Communications
    - System Tracking Testing
    - Demonstrated Technologies
- Total Contract(s) Dollar Value ~$1.5M
- Multiple Awards Anticipated
- Type of Contract – Firm Fixed Price
- Contract Awards early January 2004

# Spectrum Efficient Technology
# FY04 PRDA Contract Process

- 2004 Contract Announcement
  - PRDA 0004-C-1PKD
- Published in Fedbizopps
  - Synopsis published on 26 June 03
  - PRDA published on 22 July 03
- Contracting Officer
  - Ms. Senah Williams
    senah.williams@edwards.af.mil
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# Directed Energy Test FY04 BAA Process

- Directed Energy (DE) BAA published July 2003
- Advanced development/maturation of technologies for DE T&E
  - High Power Microwave and Laser Power Measurement on Target
  - DE-Hardened Flight Termination System/Range Destruct Package
  - DE Beam Prediction/Detection/Display
  - Modeling and Simulation to Extend Test Results
- Multiple Awards Possible
- Total Contract(s) Dollar Value ~$1.5M
- Type Of Contract – Cost Plus Fixed-Fee
- Single-year base contract with additional years as options
- Proposals due September 2003
- Contract Awards early December 2003
- All questions to Contracting POC– Mr. John Cowgill (505) 846-2242

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